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GEORGIA INSTITUTE OF TECHNOLOGY
OFFICE OF CONTRACT ADMINISTRATION

SPONSORED PROJECT TERMINATION

Date: 8/24/81

Project Title: Acquisition of a Differential Scanning Calorimeter for Polymer Research.

Project No: E-27-669

Project Director: Dr. Fred L. Cook

Sponsor: National Science Foundation

Effective Termination Date: 12/31/79

Clearance of Accounting Charges: 12/31/79

Grant/Contract Closeout Actions Remaining:

_ Final Invoice and Closing Documents
_x_ Final Fiscal ~~Report~~ Accounting (FCTR)
_x_ Final Report of Inventions
_ Govt. Property Inventory & Related Certificate
_ Classified Material Certificate
_ Other _____

Assigned to: Textile Engineering (School/Laboratory)

COPIES TO:

Project Director
Division Chief (EES)
School/Laboratory Director
Dean/Director–EES
Accounting Office
Procurement Office
Security Coordinator (OCA)
✓ Reports Coordinator (OCA)

Library, Technical Reports Section
EES Information Office
Project File (OCA)
Project Code (GTRI)
Other _____

CA-4 (1/79)

E-27-669

NATIONAL SCIENCE FOUNDATION
Washington, D.C. 20550

FINAL PROJECT REPORT
NSF FORM 98A

PLEASE READ INSTRUCTIONS ON REVERSE BEFORE COMPLETING

PART I–PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
Georgia Institute of Technology School of Textile Engineering Atlanta, Georgia 30332	Equipment for Specialized Research	ENG-78-11039
	4. Award Period From 7/15/78 To 12/31/79	5. Cumulative Award Amount $11,317

6. Project Title

Acquisition of a Differential Scanning Calorimeter for Polymer Research

PART II–SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

A duPont 990 Thermoanalyzer System including a Differential Scanning Calorimeter (DSC), Recorder Programmer, Sample Press, Cooling Accessory and Thermomechanical Analyzer (TMA) was delivered in March, 1979. Due to electrical and mechanical problems, the DSC cell base and cell and the TMA heater had to be replaced before full operation was achieved in January,1980.

The system has been utilized for a variety of research purposes. The thermal behavior of various carbon fiber precursors under different atmospheres has been assessed by DSC. The effects of acrylic precursor molecular weight, comonomer content and end-group identity on pyrolysis behavior have been assessed. The DSC has also been used to determine the morphology and crystallinity of polystyrene prepared by crown ether-assisted anionic polymerizations initiated by n-butyl lithium, as well as other polymers. The glass transition temperature of lignin separated from wood cellulose by an explosive steam depressurization process has been determined by TMA. The data proved useful in establishing processing conditions and potential applications of the lignin. The TMA was also used to evaluate differences in melting point and shrinkage of carpet yarns heat set in continuous industrial processes, and to assess the same parameters in drawn polypropylene filaments of different, known levels of orientation.

The DSC/TMA system has been utilized on five different projects to date. High-temperature (to 1800°C) DSC and Differential Thermal Analysis (DTA) cells have recently been purchased by the Institute to further expand the capabilities of the system.

PART III–TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM	
				Check (✓)	Approx. Date
a. Abstracts of Theses				X	9/81
b. Publication Citations		X			
c. Data on Scientific Collaborators		X			
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)*		N/A			

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Fred L. Cook		8/7/81

RELATED PUBLICATIONS AND PRESENTATIONS

1. F. L. Cook* and D. Hartman, "Effect of Molecular Weight on the Pyrolysis of Polyacrylonitrile," Amer. Chem. Soc., Cell./Paper/Text. Preprints, 182, 41 (1981) (Copy attached)

2. F. L. Cook* and D. Hartman "Effect of Molecular Weight on the Pyrolysis of Polyacrylonitrile," in preparation for submission to J. Poly. Sci.

3. F. L. Cook* and D. Hartman, "Effect of Molecular Weight on the Pyrolysis of Polyacrylonitrile", Presentation, Symposium on "Thermal Properties of Fibers," New York, N.Y., August 26, 1981.

4. W. C. Tincher*, F. L. Cook and A. S. Abhiraman, "Precursor Structure - Fiber Property Relationships in Polyacrylonitrile-Based Carbon Fibers", Annual Technological Report, Office of Naval Research Contract No. N000 14-79-C-0523, School of Textile Engineering, Georgia Institute of Technology, Atlanta, Georgia, May 26, 1981. Final Report in preparation.

5. A. S. Abhiraman* and J. Song, "Drawing Rate Effects on Morphological Parameters in Nylon 6, PBT and PET Filaments", Submitted to J. App. Polym. Sci. for publication, July, 1981.

6. A. S. Abhiraman* and M. Jain, "Morphology of Precursor in PAN-Based Carbon Fibers", in preparation.

7. A. S. Abhiraman* and A. Hamidi, "Relaxation and Crystallization of Oriented PET", in preparation.

8. W. C. Tincher* and M. E. Pfister, "TMA Response Differences in Fibers from Heat-Set Carpet Yarns", Report to WestPoint Pepperell Co., August, 1981.

Scientific Collaborators

A. School of Textile Engineering

1. Faculty

Dr. F. L. Cook, Assoc. Prof.
Dr. W. C. Tincher, Acting Director
Dr. A. S. Abhiraman, Asst. Prof.

2. Research Associates

M. E. Pfister
M. Averette

3. Graduate Students

M. Jain, Ph.D.
J. Song, M.S.
A. Hamidi, M.S
C. Kleissler, M.S.
R. Brooker, Ph.D.

B. School of Chemical Engineering

1. Faculty

Dr. J. D. Muzzy, Prof.
Dr. R. J. Samuels, Prof.

2. Students

K. Fieber

C. School of Mechanical Engineering

1. Faculty

Dr. J. T. Berry

TECHNICAL DESCRIPTION OF PROJECT AND RESULTS

A duPont 990 Thermoanalyzer System including a DSC, a TMA and accessories was purchased and rendered operational in January, 1980. The system has been utilized for a variety of research purposes, including analysis of the pyrolysis behavior of carbon fiber precursors, morphology/crystallinity of anionic-polymerized polystyrene, glass transition temperature of lignin from wood pulp and shrinkage/melting points of heat set carpet yarns and oriented polypropylene filaments. Subsequent purchase of high temperature (to 1800°C) DSC and DTA cells have expanded the system capabilities.

AMERICAN CHEMICAL SOCIETY
CELLULOSE, PAPER AND TEXTILE DIVISION

182nd ACS National Meeting

New York, New York
August 23-28, 1981

R.E. Read, Chairman
R.D. Gilbert, Secretary/Treasurer

CELL

O THURSDAY MORNING AND AFTERNOON - SECTION A - SYMPOSIUM ON THERMAL PROPERTIES OF FIBERS - I & II - T.L. Vigo, Presiding

41. EFFECT OF MOLECULAR WEIGHT ON THE PYROLYSIS OF POLYACRYLONITRILE. F.L. Cook and D. Hartman. Georgia Institute of Technology, School of Textile Engineering, Atlanta, Georgia, 30332

DSC scans of the degradation of PAN under air revealed substantial differences depending on the $\overline{Mv}$ of the sample. The intensity of the typical exotherm peak in the 255°-306°C range decreased substantially as $\overline{Mv}$ was decreased, while a second exotherm peak appeared in the 252°-255°C range and grew in relative intensity as $\overline{Mv}$ decreased. Both suspension- and solution-polymerized samples showed the same general behavior. Theories are presented to explain the observations based on the concentration of end groups in the solid state structure, length of properly-aligned nitrile sequences and starvation of the higher-temperature exotherm by initial link up of the nitriles. Correlation with literature reports and potential significance in carbon fiber formation are discussed.